Understanding Compressed Air Load Profiles and Peak Demand Management

Mauricio Uribe
Compressed Air Consultants
Keynote Speaker

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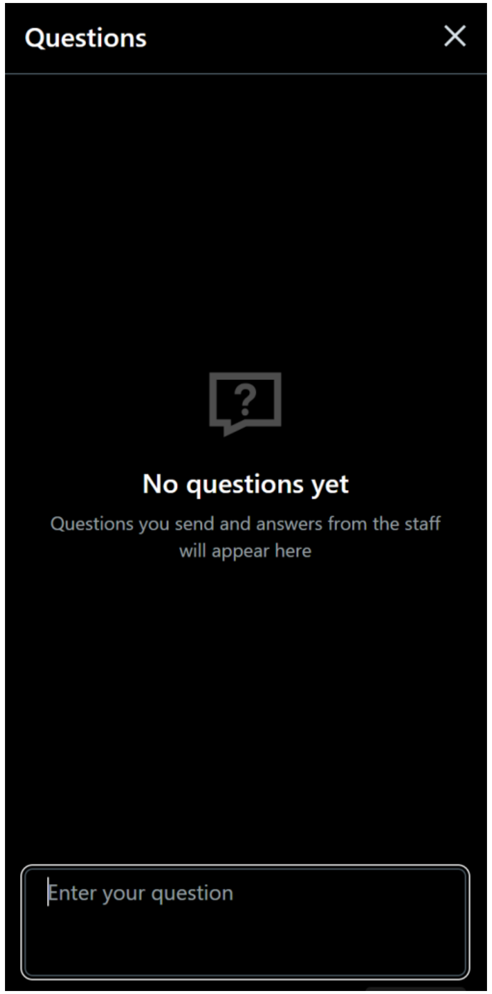

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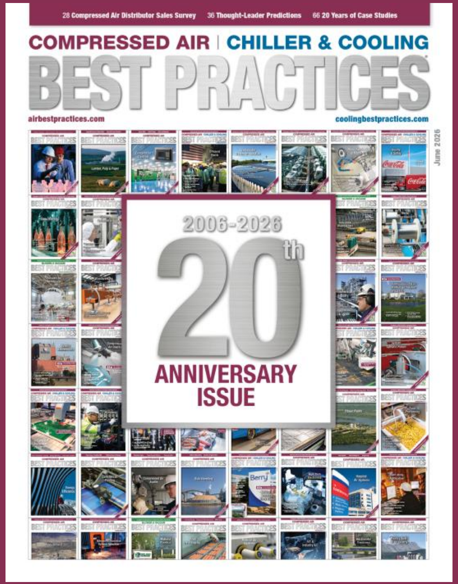
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All materials presented are educational. Each system is unique and must be evaluated on its own merits.

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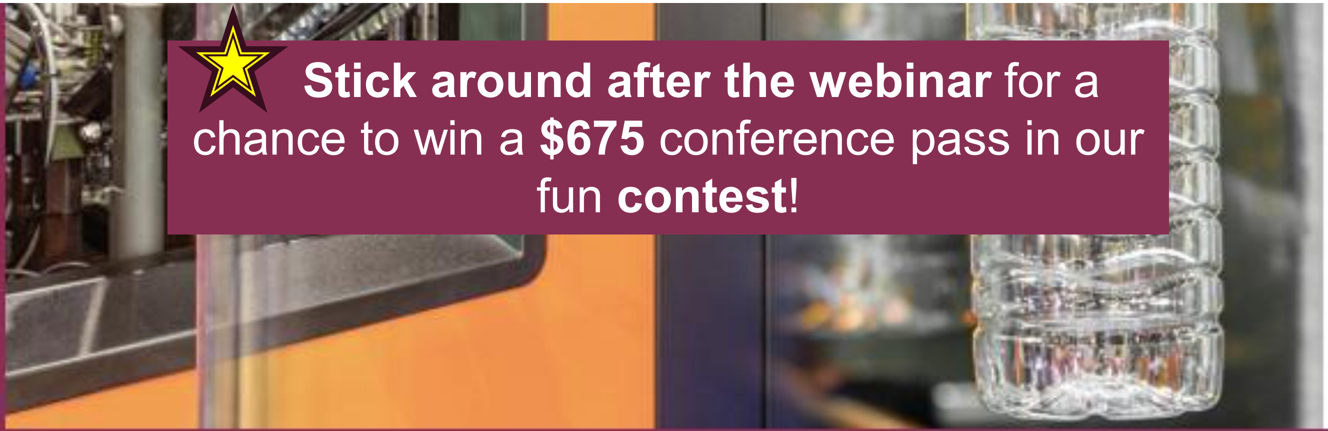

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Understanding Compressed Air Load Profiles and Peak Demand Management

Introduction by

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About the Speaker

Mauricio Uribe
Compressed Air Consultants

- Head of European Operations, Compressed Air Consultants
- Mechanical Engineer with 30+ years in compressed air systems
- Auditing compressed air systems since 2003
- 100+ audits for world-class companies across five continents

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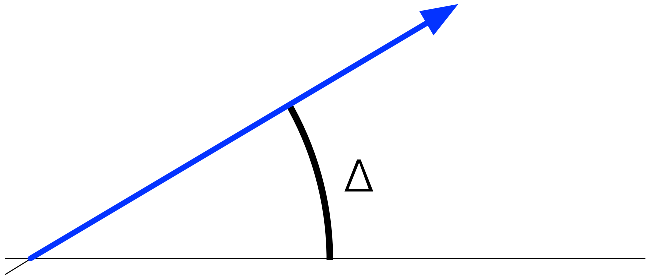
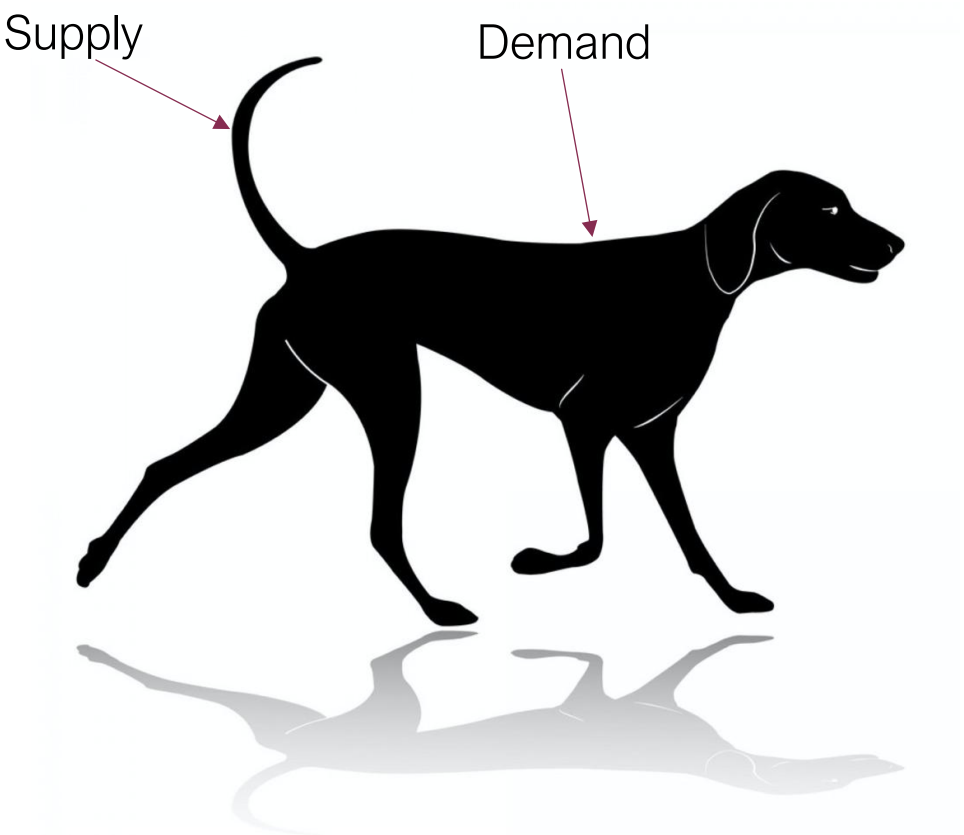
Understanding Load Profiles & Peak Demand Management

Mauricio Uribe, Sr. Auditor
Compressed Air Consultants



It’s About Money, Not Air

Dynamics of a Compressed Air System



Supply Responds to the System Demand

Supply Side bears all the costs

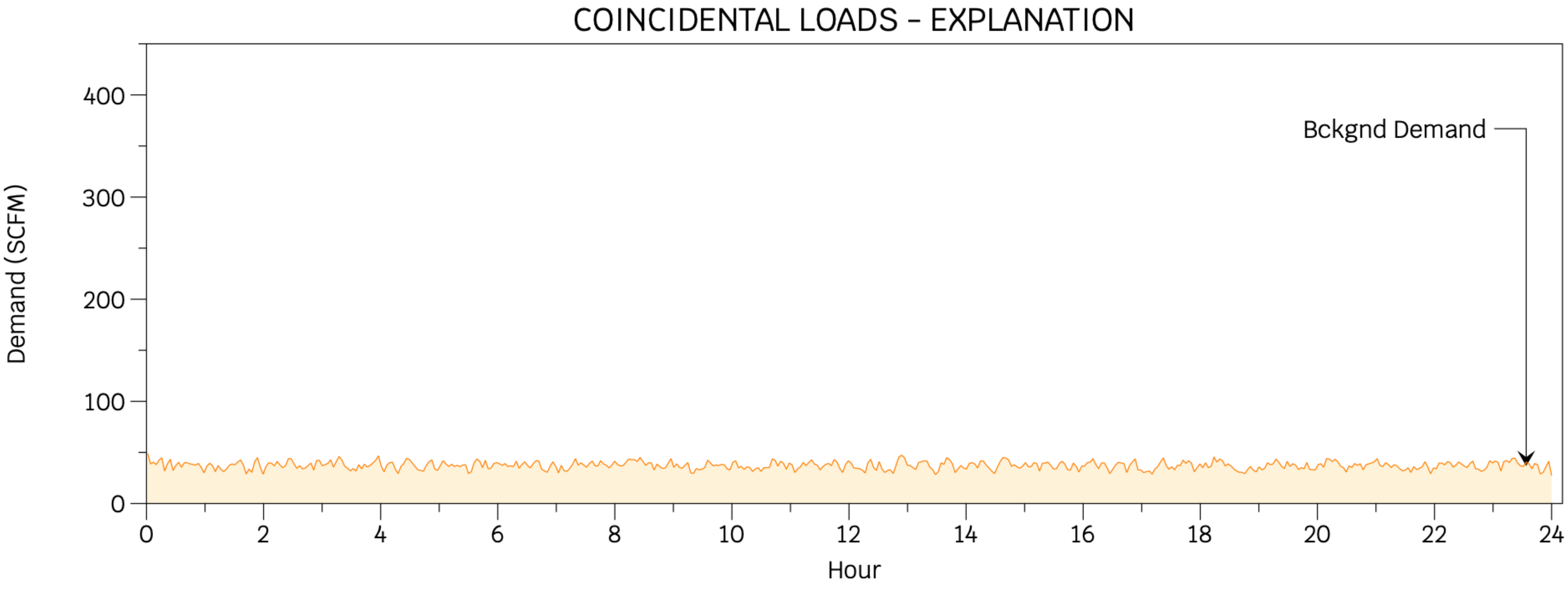
- Capital Expenditures
- Power Consumption
- Cooling Water
- Maintenance & Rental

Know thy demand

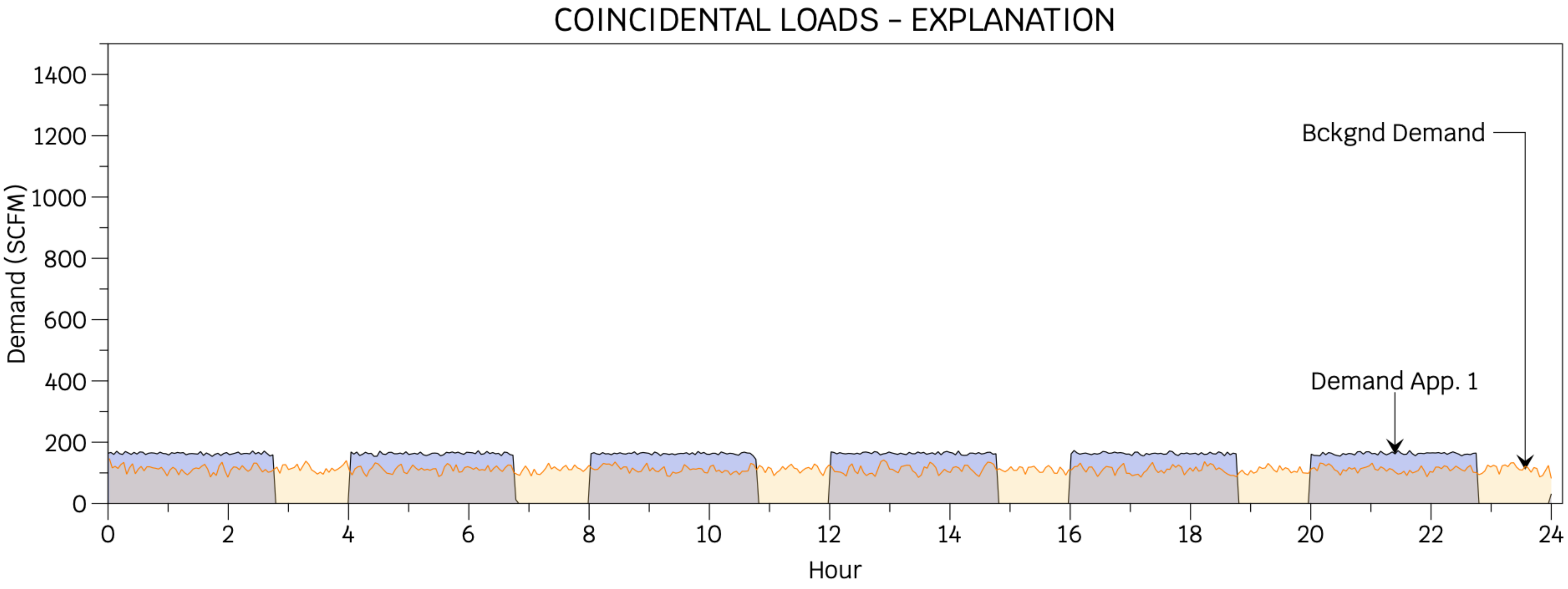
Constituents of Demand

- Background Demand
- Process-Related Demand
- Coincidental Demand Peaks
- Unpredicted Air Usage

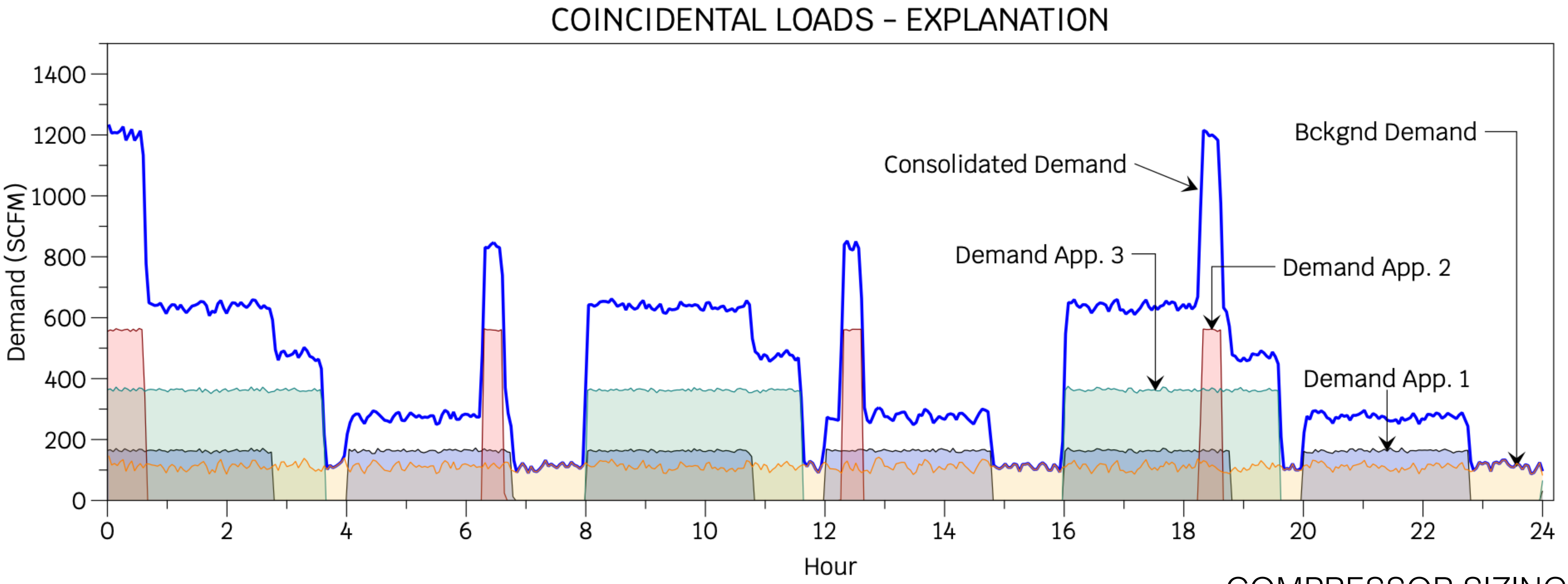
Demand Profile



Demand Profile

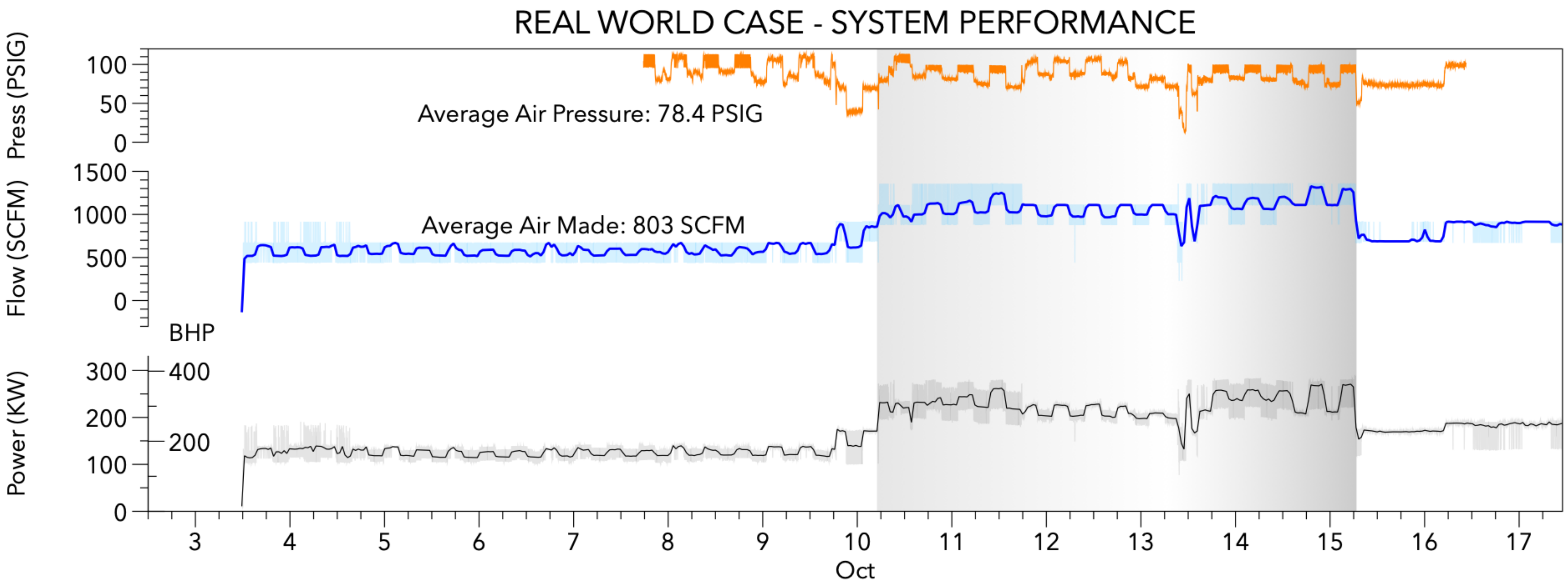


Demand Profile

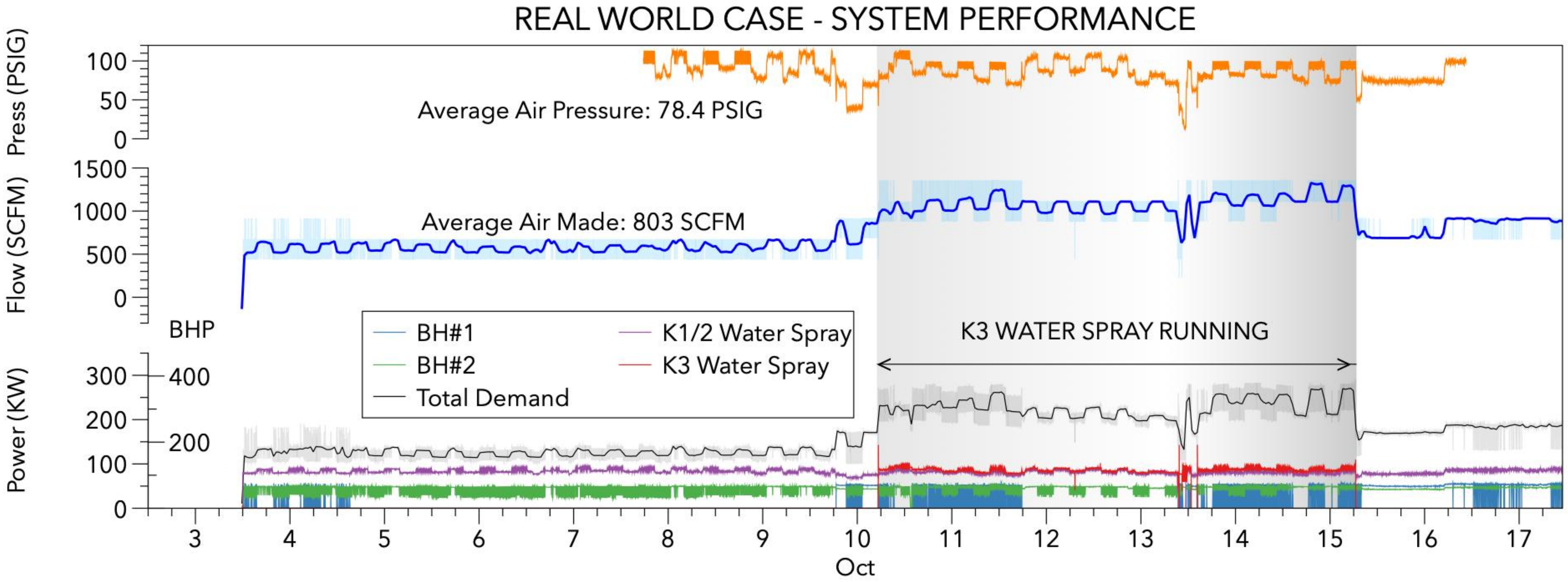


COMPRESSOR SIZING

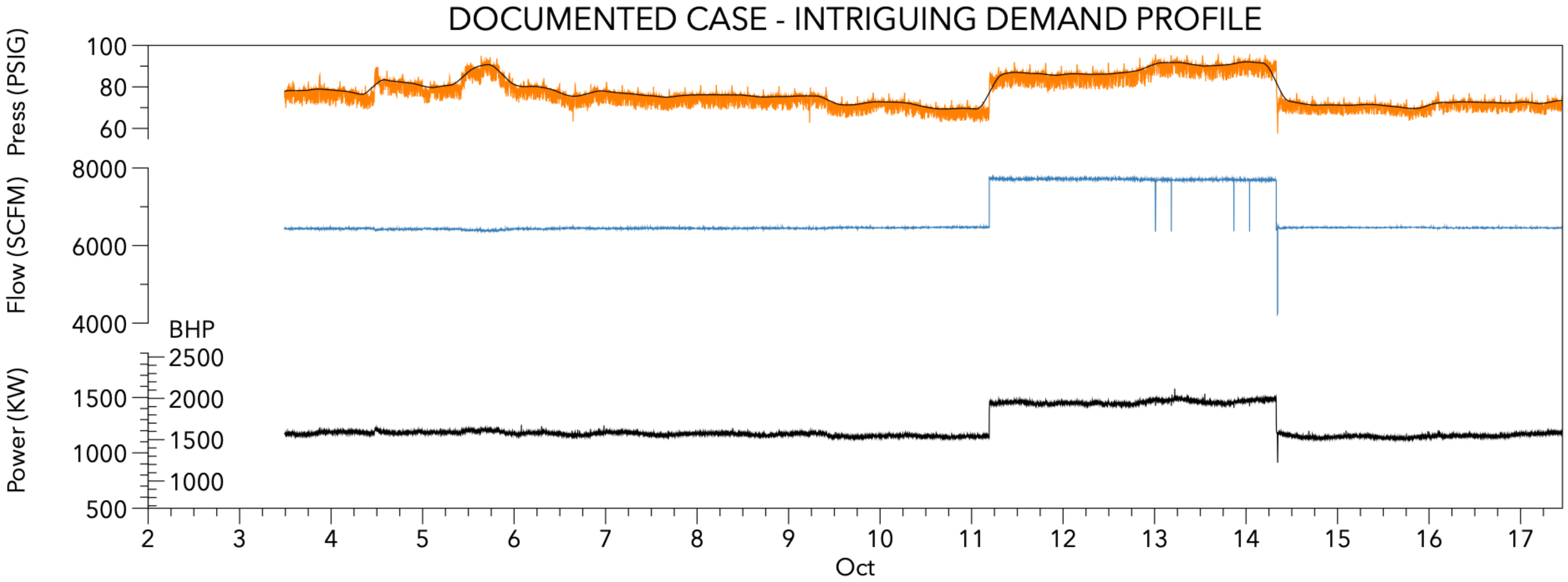
Real World Systems – Demand Profile



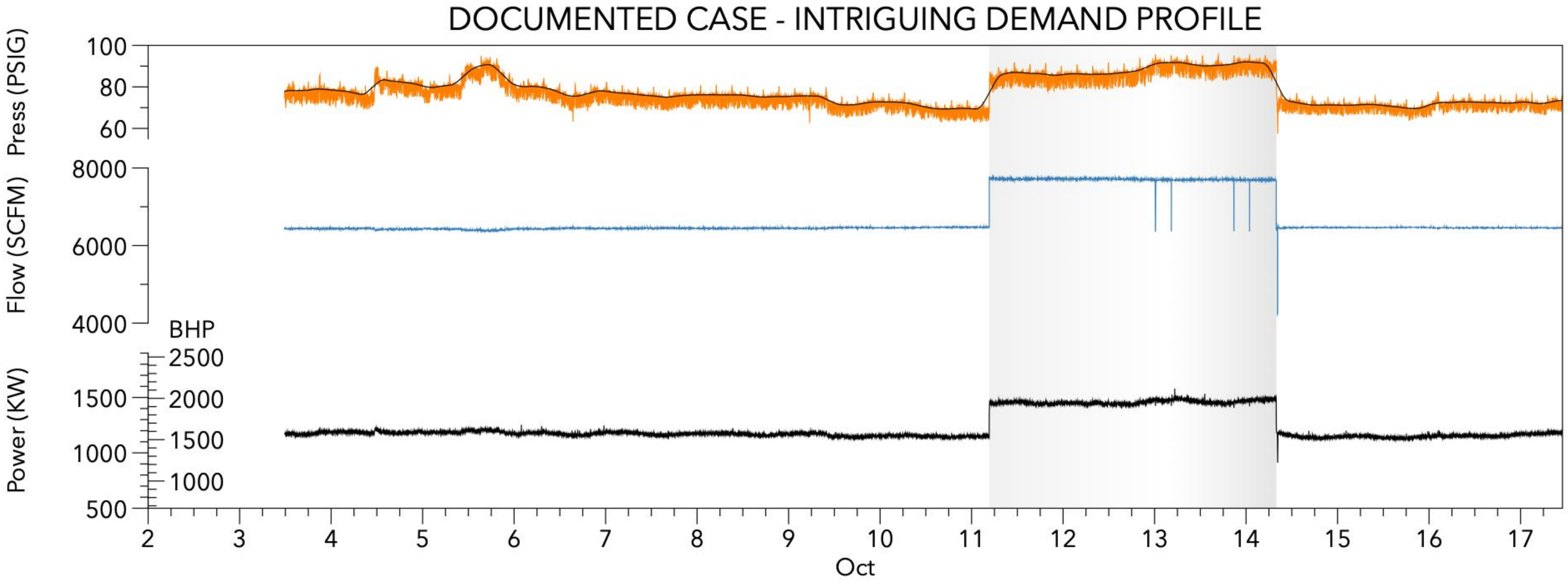
Real World Systems – Demand Profile



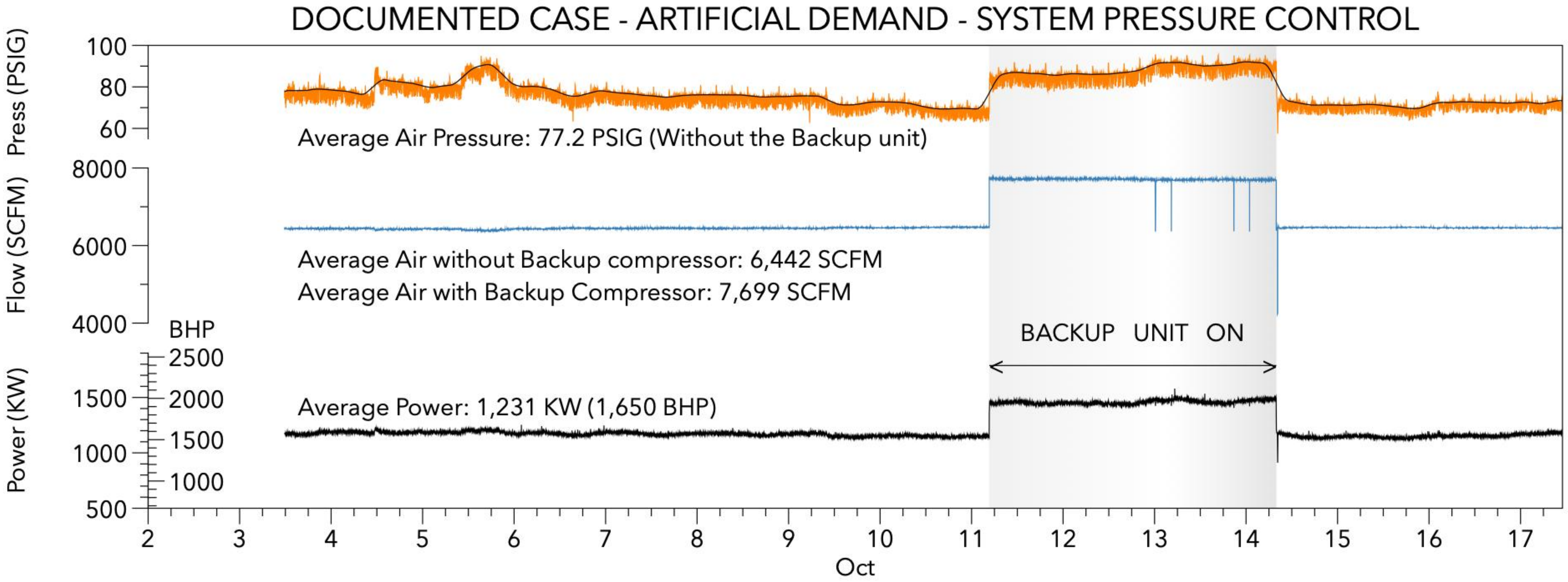
Real World Systems – Demand Profile



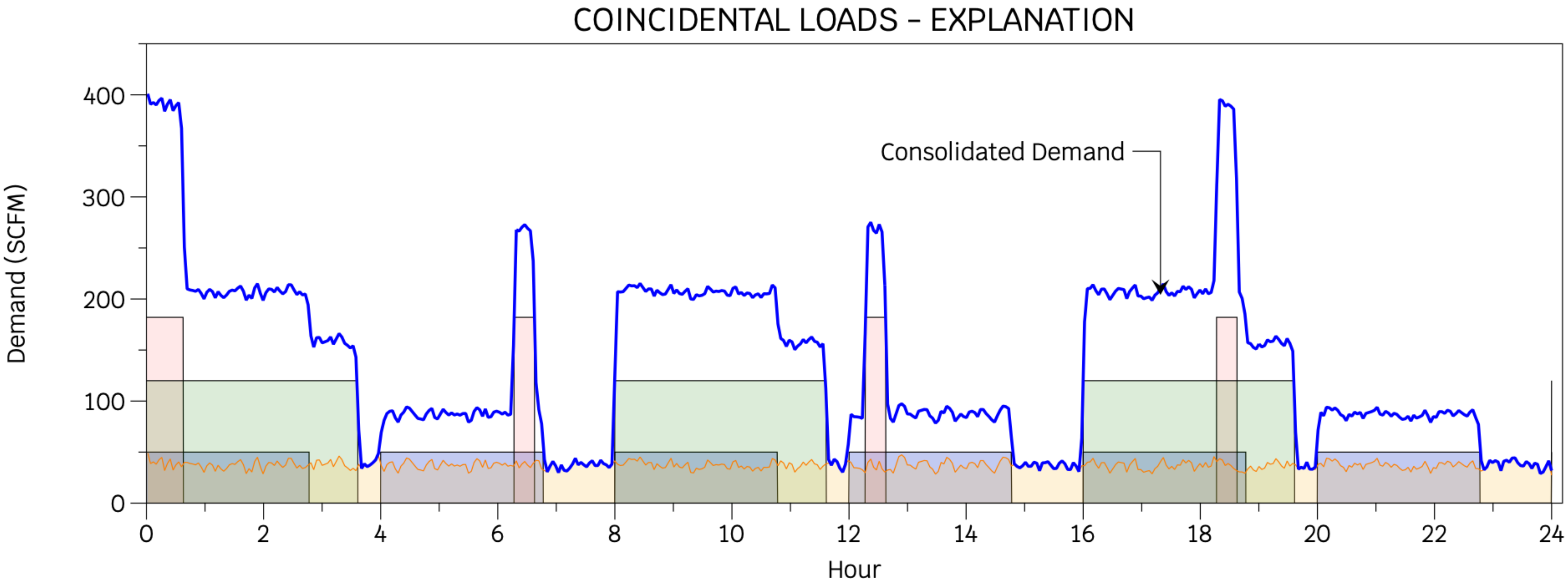
Real World Systems – Demand Profile



Real World Systems – Demand Profile



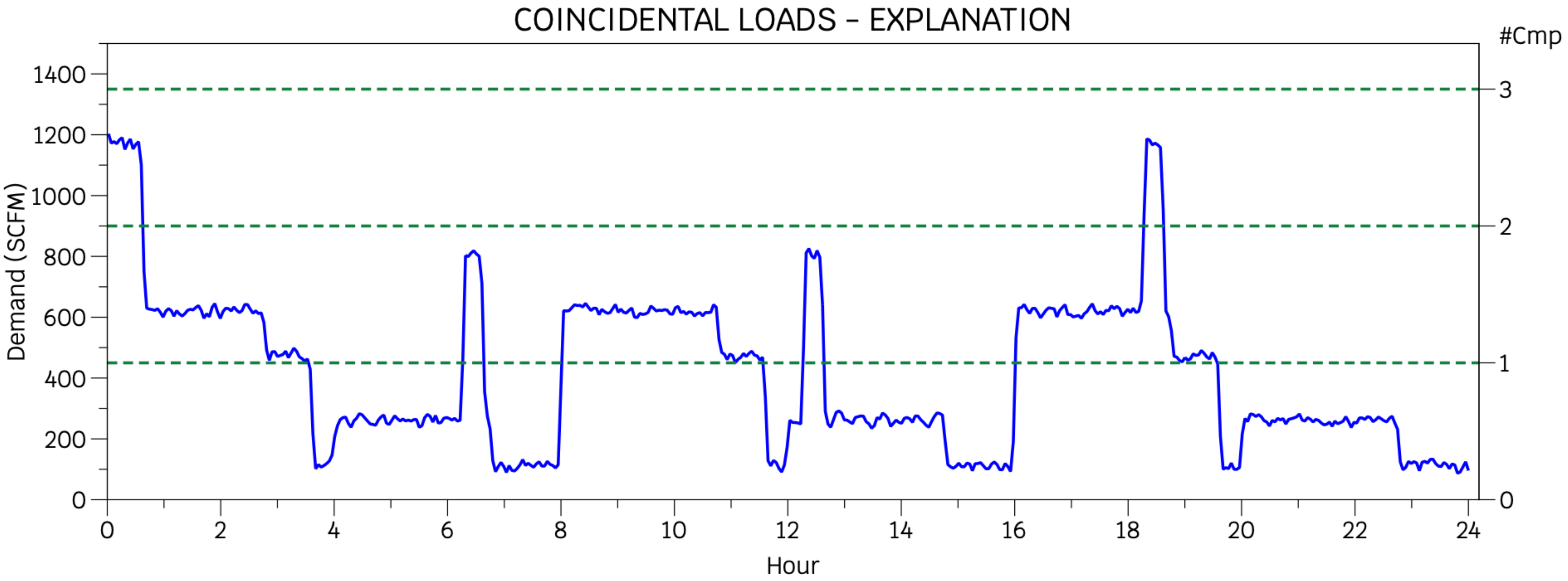
Demand Profile



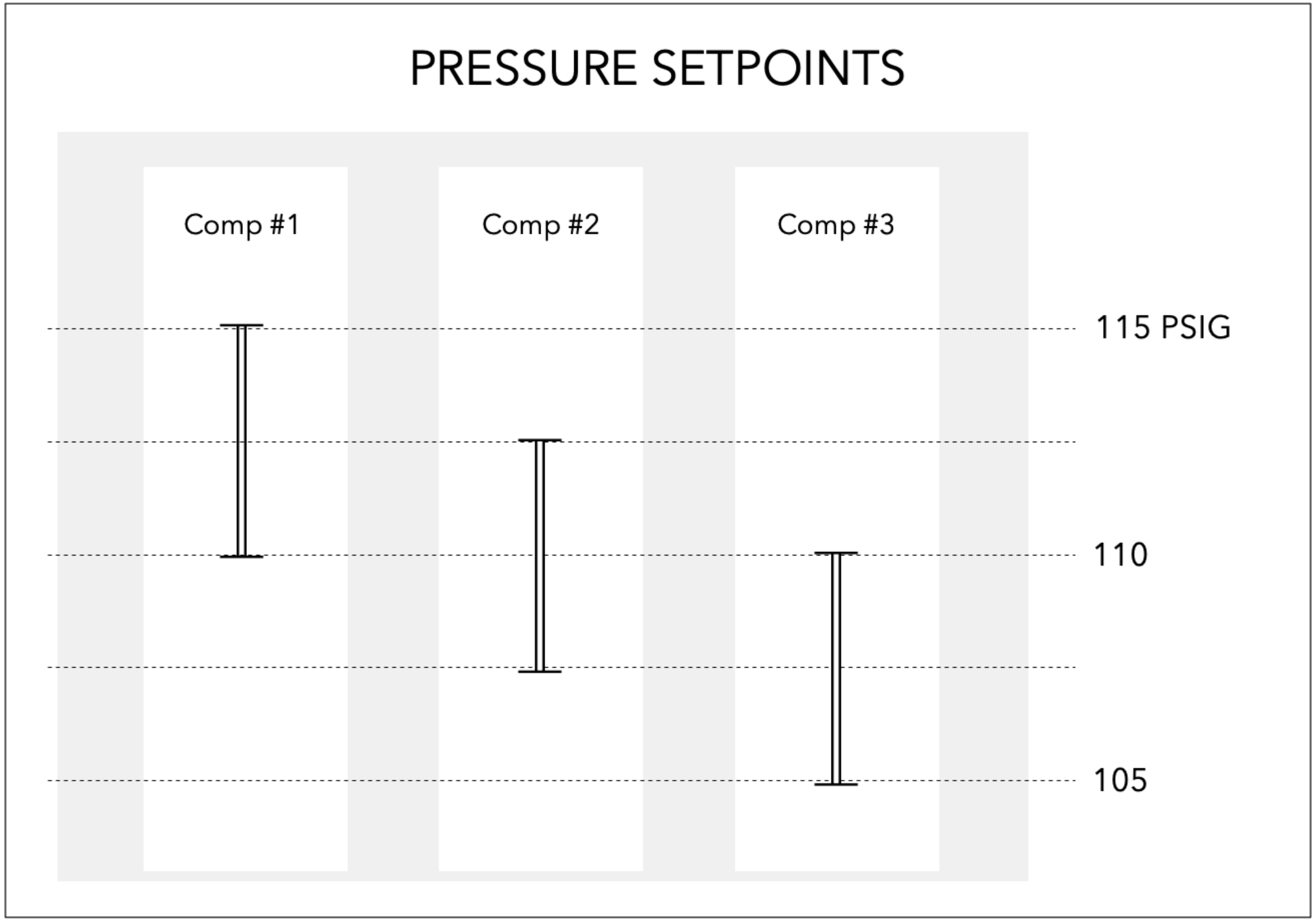
Supply Sizing

- System Capacity - sized to cover full demand
- Compressor Selection – Ideally matched to demand profile tiers
- Compressor / Operation Interlocks
- Controls

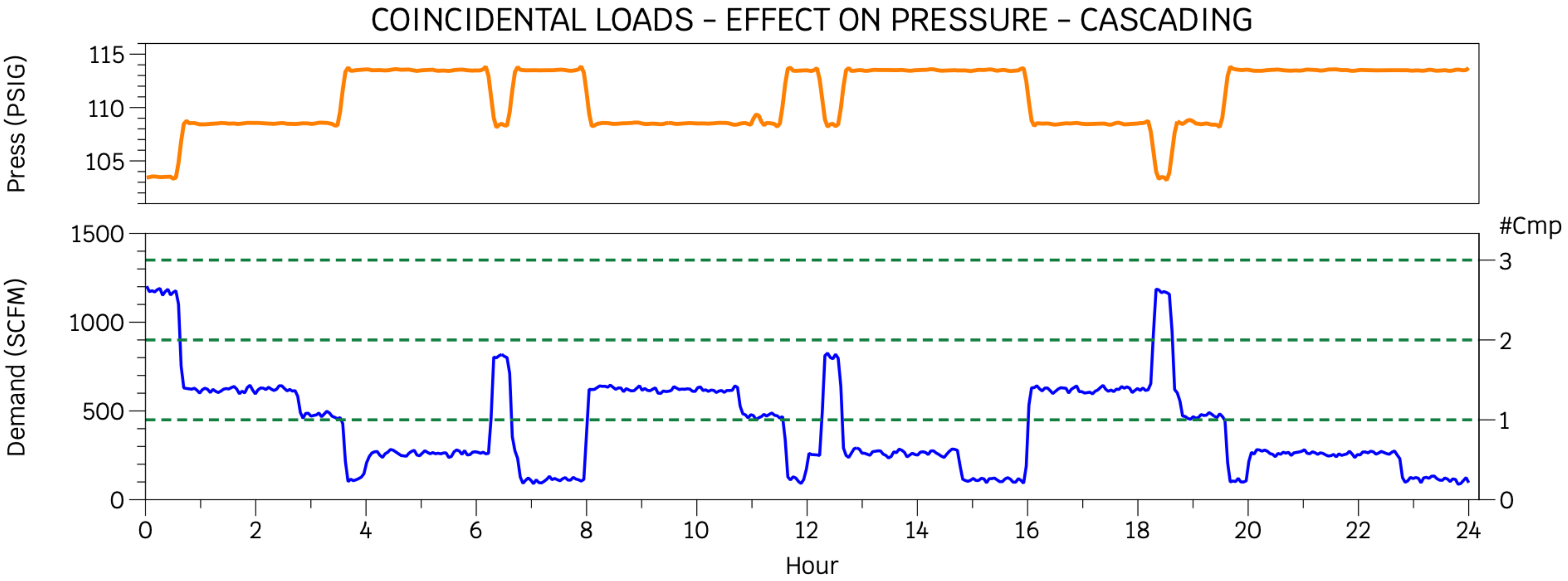
Adapting to a Demand Profile



Adapting to a Demand Profile

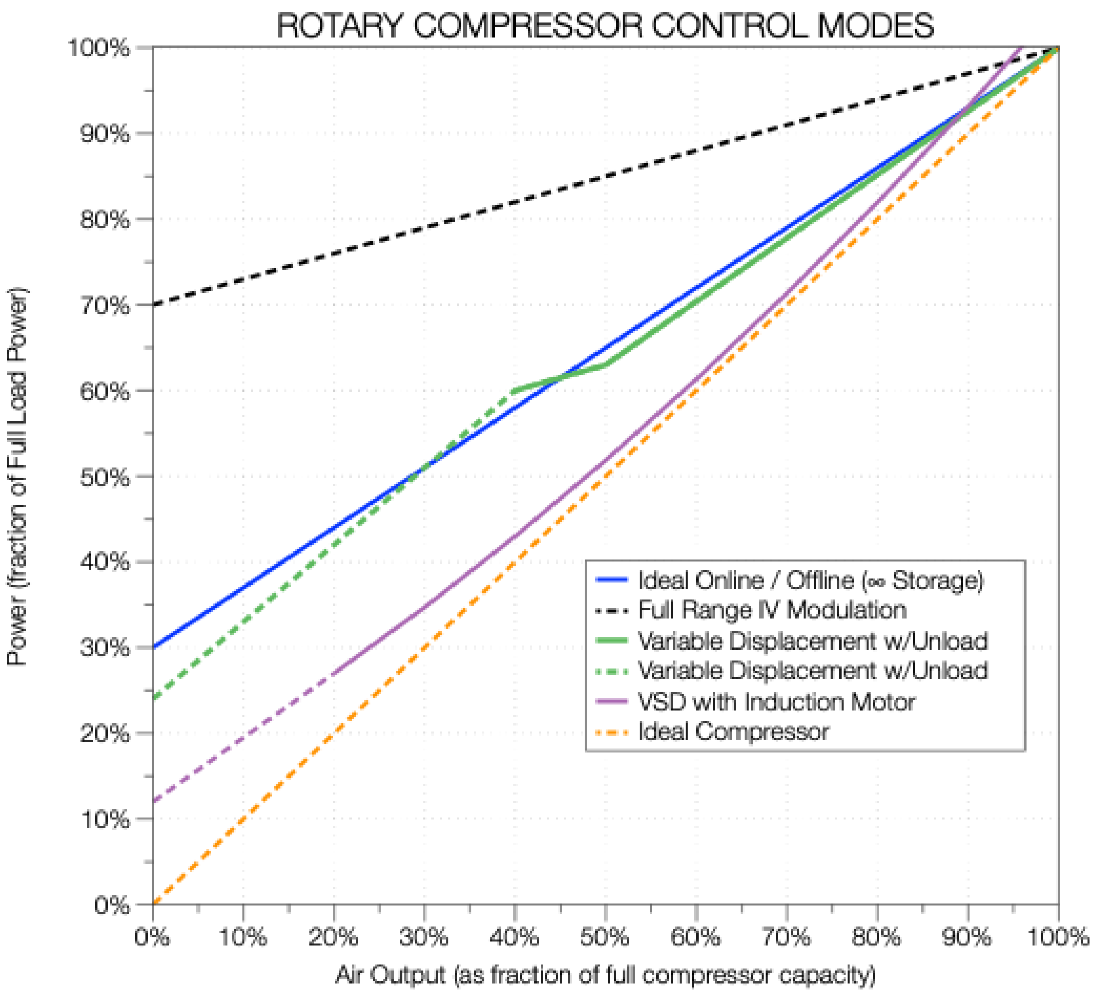


Adapting to a Demand Profile

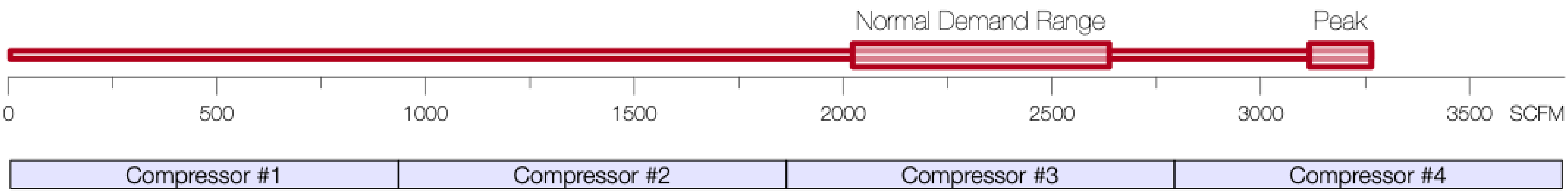


Controls

- Capacity Control
  - Matches Supply to Demand
  - Different methods
  - Different Turndown Ranges

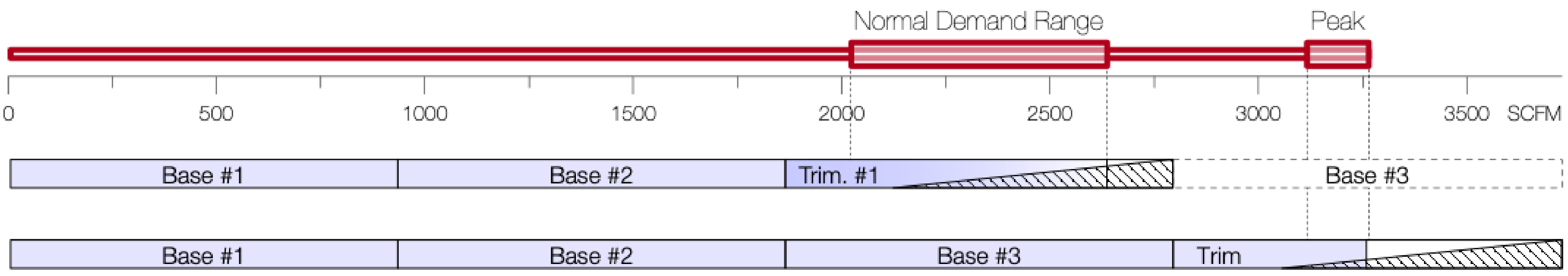


Control Strategy



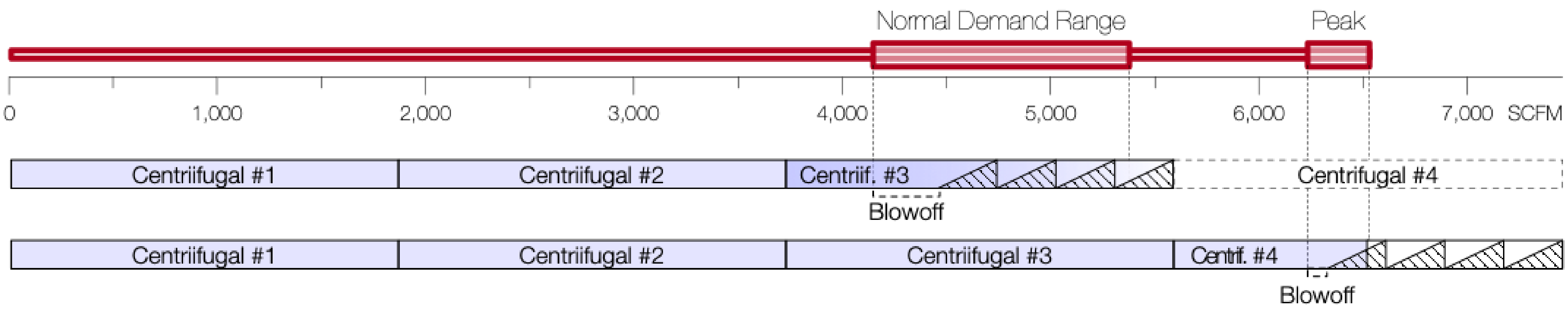
- N + ~1 Strategy (Backup / peak load compressor)
- Common Pressure Band

Control Strategy



- Base / Trim strategy
- Mind the [control] Gap
- Multiple compressor systems – High-end controller

Control Strategy – Centrifugal compressors



- Centrifugal Turndown Ranges
- [Smart] Load Sharing

Recommendations

- Size for Maximum Demand
- Adapt Control Strategy to Demand Profile
- Common Band Pressure control
- Adequate Storage
- Evaluate if independent / prioritized systems would be a better fit for larger loads
  - Interlocked compressors
  - System Integration

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About the Speaker

David Miller
FS-Elliott

- Product Manager, Industrial Products
- 6.5+ years with FS-Elliott
- Former Applications Engineer focused on compressor sizing
- B.S. Mechanical Engineering, University of Pittsburgh

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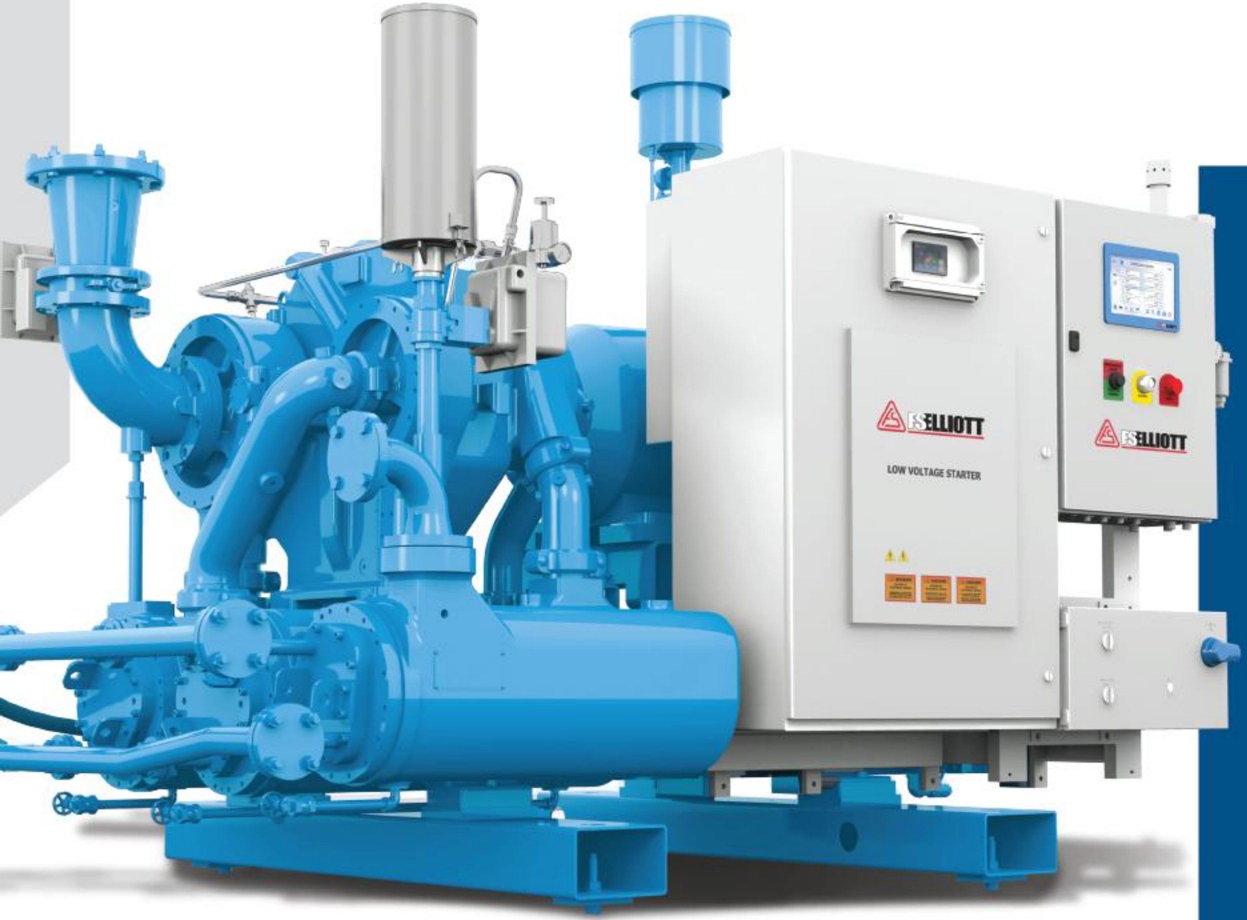


From Air Demand to Smarter Compressor Systems

David Miller

Product Manager, Industrial Products

FS-Elliott Co., LLC

Understanding Your Load Profile

What Is a Load Profile?

A load profile is a record of how compressed air demand varies over time — across a shift, a day, or a season.

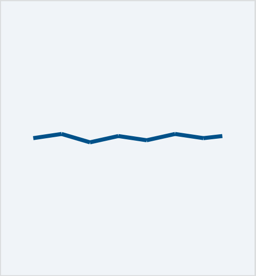
It captures not just how much air your facility needs, but when it needs it and how consistently demand rises and falls.

Key insight:

The shape of the load profile — not just the peak — determines the right system design strategy.

Flat / Steady

Consistent demand with little variation. One well-sized base-load machine often suffices.



Variable / Cyclical

Demand rises and falls on a predictable schedule. Requires responsive trim capacity.

Spiky / Unpredictable

Frequent short-duration peaks. Needs peak management — storage, controls, or fast-response trim units.

The Problem with Peak-First Design

Most systems are engineered for worst-case demand — but peak conditions are rarely the norm.

1

Oversized for Worst Case

Systems sized at peak demand spend most runtime well below full load — wasting energy at partial capacity.

2

Inefficient Control Behavior

Compressors cycling in blow-off or unloaded states signal a mismatch between system capacity and real operating demand.

3

The Cost Is Real

Energy is the largest lifecycle cost of a compressed air system — often exceeding capital cost over a 10-year period.

The gap between peak capacity and average operating demand is where efficiency — and money — is lost.

Translating Demand Data into System Strategy

A well-designed system layers three functional roles — each matched to a different portion of the load profile.

01 Base Load

Runs continuously at high efficiency

Sized to meet the consistent floor of air demand and operated near full load for maximum efficiency.

Centrifugal compressors are the preferred choice — oil-free, highly efficient at design point, and well-suited to continuous large-volume duty.

02 Trim Capacity

Responds to demand variation

Fills the gap between base load and actual demand. Must perform efficiently across a wide operating range.

VSD rotary screw compressors are common trim machines. In larger systems, a smaller centrifugal may serve this role. Multiple units can improve granularity and redundancy.

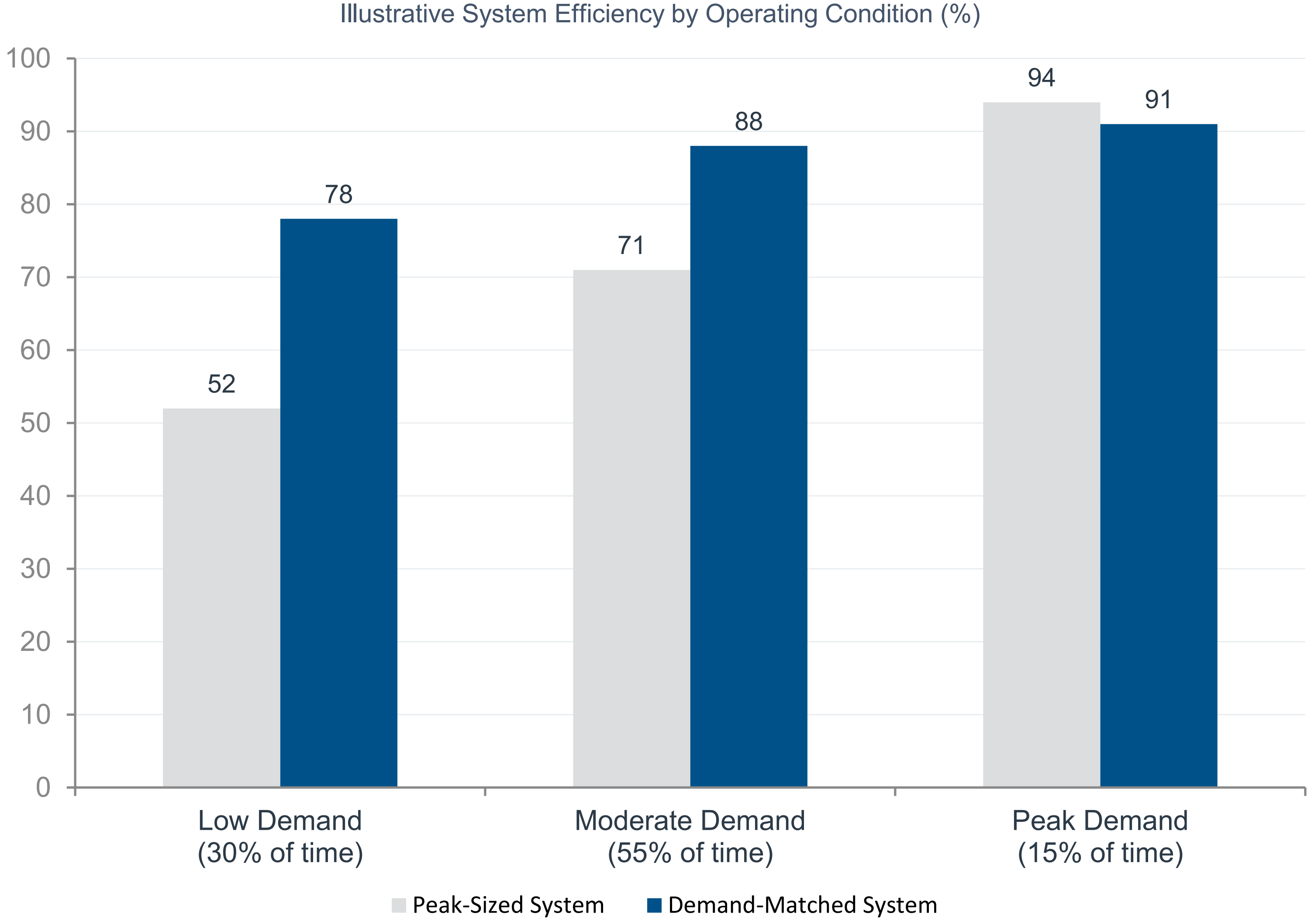
03 Peak Management

Handles short-duration spikes

Compressed air receiver tanks are often the most cost-effective peak management tool — stored air absorbs brief demand spikes without requiring additional compressor capacity.

Tanks respond instantly and add no operating cost, making them the first solution to evaluate before adding equipment.

The Efficiency Gap: Peak vs. Demand-Matched Design



~15–20%

typical efficiency loss at low-demand conditions in a peak-sized system

55%

of industrial runtime is at moderate demand — not at peak

Energy

is the #1 lifecycle cost — efficiency gains compound year over year

** Illustrative values representative of typical industrial installations. Actual performance varies by system configuration, compressor type, and operating conditions.*

Practical Principles for Smarter System Design

Applying load profile data to system design comes down to a few guiding principles:

1	**Design for your entire operating band — not just your peak**	Identify the air demand range where your facility spends 80%+ of its runtime. Optimize your system for that range first.
2	**Size each compressor for the role it needs to play**	Base-load machines should run near full capacity for maximum efficiency — centrifugals excel here. Trim machines must perform well across a wide range, not just at peak — evaluate part-load curves, not just rated capacity.
3	**Address peak demand with storage before adding capacity**	Receiver tanks are often the most cost-effective solution for short-duration spikes, without adding a compressor.

Key Takeaways

- Understand your load profile — the shape, not just the peak, drives smarter system design.
- Layer your system: base load for consistency, trim for variation, storage for spikes.
- Part-load efficiency matters more than full-load ratings for most facilities.
- Revisit your system strategy as production demands evolve over time.

FS-Elliott designs centrifugal compressors built for efficiency across a wide operating range — engineered for real load conditions, not just peak.

David Miller

Product Manager, Industrial Products

FS-Elliott Co., LLC

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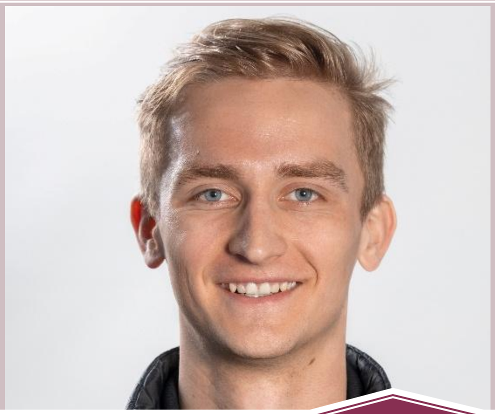
About the Speaker



Jackson Redline
Rogers Machinery

- Engineered System Solutions Manager, Rogers Machinery
- Mechanical Engineer on the Engineered Systems team
- 10 years with Rogers Machinery

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Water-Cooled vs. Air-Cooled Air Compressors

Jackson Redline

Engineered Systems Solutions

Summary

1. Why do compressors need cooling?
2. Air-cooling for compressors
3. Water-cooling for compressors
4. When to chose which cooling method
5. Fun things to do with your compressor cooling

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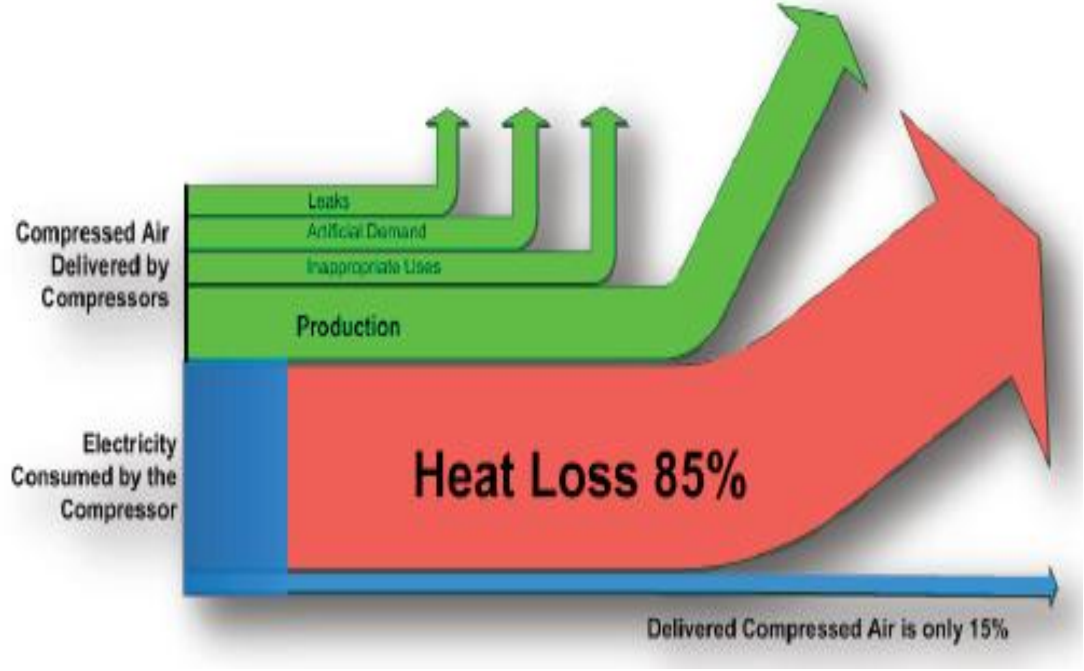
Compressing Gas = HEAT

- Compressing gas generates A LOT of heat
- 80-90% (or more) of energy consumed by the compressor will become heat energy
- Everything in the compression system gets hotter (gas, casing, rotors, lubricant if applicable)
- Sources of heat generation:
  - Friction
  - Transfer of mechanical power
- Air compressors are not adiabatic or isothermal compressors
  - Impossible to 100% insulate to be a true adiabatic compression
  - Impossible to keep temperature the same during compression



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IDEAL GAS LAW

$$PV = nRT$$

P … Pressure

V … Volume

n … number of moles

R … Ideal Gas Law Constant

T … Temperature

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WHY COOL MY AIR COMPRESSOR?

- Cold air is more dense
  - Same air compressor can process more air if the air is colder than a hot air compressor
- Higher temperatures can wear out seals and elastomers faster (dry out and crack) OR require more expensive materials.
- Reducing the air temperature will reduce water vapor out of the gas stream
  - Moisture can cause equipment failures
  - Reduced temperatures at discharge lead to smaller dryers (less $$$ spent)

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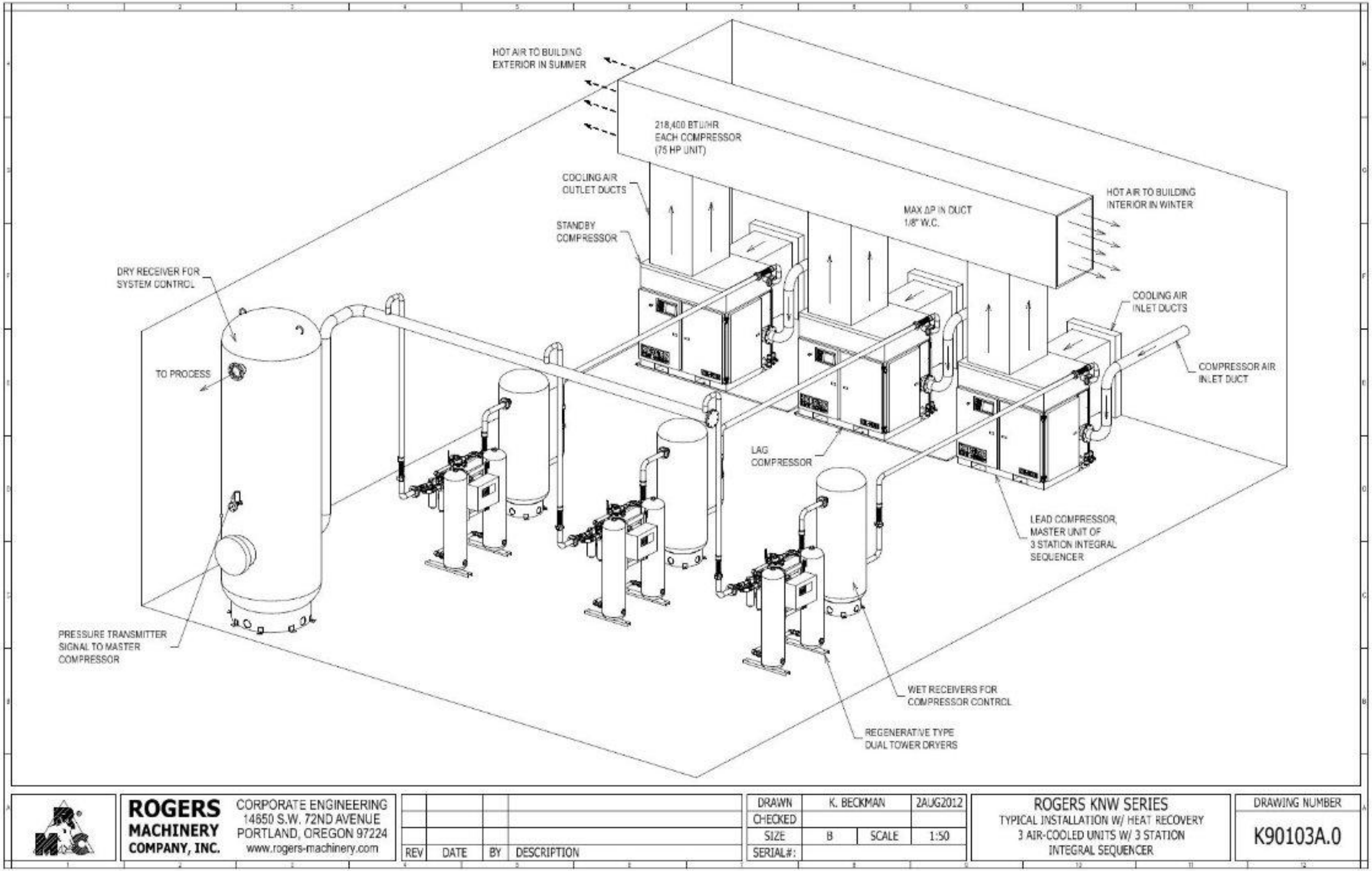

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WATER-COOLING

BENEFITS:

- Water is more effective at cooling than air
  - water is a good conductor of heat and absorbs it readily
- Smaller cooling systems than compared to air-cooled of same HP
- Quieter – no cooling fans required
- More predictable operation

LIMITING FACTORS:

- More infrastructure required (chillers, piping, instrumentation, etc.) to maintain cooling water system
- Adds additional system to maintain for compressor operation
- Adding more capacity to systems can cascade into more scope for customers
  - More cooling demands = more flow = larger pumps/chillers/piping/instrumentation

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WATER-COOLING CONT.

- Air compressors are generally not picky on cooling water temperatures
  - 40-95 ºF(or hotter in limited cases)
  - Too cold or too much flow can cause issues (condensation, dwell time, thermal shock)
- Compressors can be used to “pre-heat” water before heat recovery, boilers, etc. to save on energy costs
  - Compressor operating conditions can be tweaked to drive higher temperatures and in turn heat the water better BUT that comes at the cost of energy efficiency for the compressor (hotter ≠ more efficient)
  - Control is generally by “letting water out” of the coolers instead of inlet side control to reduce possibility of an empty cooler

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WHEN TO CHOSE AIR OR WATER?

- Is there cooling water available at the site?
  - If not – are there current plans to add one? Or is it viable for a new closed loop system to be installed to support the compressor(s)?
  - If yes – can that system support more heat and flow loads?
- Where is the equipment going to be installed?
  - Indoors or outdoors?
  - If indoors can there be adequate airflow?
- What are the minimum and maximum ambient temperatures?
  - Does it get below freezing?
  - What is the maximum ambient temperature?

Questions?

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What do you call the chance that several independent tools may run at the same time?

A
- Background Demand

B
- Process-related Demand

C
- Coincidental Load

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*By entering you are giving permission to announce your name if you are a winner

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Understanding Compressed Air Load Profiles and Peak Demand Management

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